DOCUMENT RESUME

ED 479 573 IR 022 156

AUTHOR	Hsu, Ti; Wang, Hsiu Fei
TITLE	Development of an Internet Collaborative Learning Behavior Scale--Preliminary Results.
PUB DATE	2002-10-00
NOTE	9p.; In: E-Learn 2002 World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education. Proceedings (7th, Montreal, Quebec, Canada, October 15-19, 2002); see IR 022 093.
AVAILABLE FROM	Association for the Advancement of Computing in Education (AACE), P.O. Box 3728, Norfolk, VA 23514. Tel: 757-623-7588; e-mail: info@aace.org; Web site: http://www.aace.org/DL/.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS
DESCRIPTORS	*Cooperative Learning; Elementary Secondary Education; *Learning Strategies; Learning Theories; Mathematics Achievement; *Mathematics Instruction; Mathematics Skills; Problem Solving; Student Evaluation; *Teamwork

ABSTRACT

It is well known that math phobia is a common problem among young school children. It becomes a challenge to educational practitioners and academic researchers to figure out ways to overcome the problem. Collaborative team learning has been proposed as one of the alternatives. This study was part of a large and ongoing research project designed to help students learn math in a collaborative fashion using a Web-based intelligent system in a virtual reality environment and then to study their learning behaviors. The purpose of this part was to develop an instrument to measure the learning behavior of Taiwan's eighth graders in their learning of the "Pythagorean Theorem." A principal component analysis with the Oblimin procedure was utilized to analyze the 44-item Internet collaborative learning behavior scale (ICLBS). The preliminary results revealed that a model with five-factors deriving from 39 items was the best model. (Contains 26 references.) (Author)

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Development of An Internet Collaborative Learning Behavior Scale – Preliminary Results

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Ti Hsu
Department of Business Administration
Tamkang University
Taipei, Taiwan, R.O.C.
th4657@yahoo.com

Hsiu Fei Wang
Da Yeh University and New York University

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Abstract: It is well known that math phobia is a common problem among young school kids. It becomes a challenge to educational practitioners and academic researchers to figure out ways to overcome the problems. Collaborative team learning has been proposed as one of the alternatives. The present study was part of a large and an on-going research project designed to help students learn math in a collaborative fashion using a Web-based intelligent system in a virtual reality environment and then to study their learning behaviors. The purpose of this part was to develop an instrument to measure the learning behavior of Taiwan's 8th graders in their learning of the "Pythagorean Theorem." A principal component analysis with the Oblimin procedure was utilized to analyze the 44-item internet collaborative learning behavior scale (ICLBS). The preliminary results revealed that a model with five-factor deriving from 39 item was the best model.

Introduction

Math has always been a very difficult subject to many elementary and/or junior high school students. For years, educational practitioners and academic researchers have continuously worked hard to generate new ideas or alternatives hoping to help alleviate the pressure for students to learn math.

Collaborative learning has been offered as one such alternative to the traditional way of teaching and/or learning. Unlike individualized learning, collaborative learning tends to place heavy emphasis on cooperative learning and the development of certain important skills, such as thinking, interpersonal, and problem solving, etc.

Plowman's (1988) cooperative team learning theory claimed that students could be encouraged to learn on their own through discovering and experiencing themselves, which in turn would also motivate them to learn more willingly. This would be an ideal way of learning and might be deemed as the most effective way of learning. This is why researchers believed that cooperative team learning not only tended to offer better learning than individual learning, but also helped students enhance their self-esteem (Salvin, 1990; Sharan & Shacher, 1988). A better and effective learning provided through the "cooperative team learning" was further supported by the findings of two separate research (Johnson & Johnson,1989; Cooper, et al 1990). Another study undertaken by Webb (1991) revealed that students could obtain better grades if they would participate actively in the team discussion, or if they could answer questions that other members might have, or if they could explain the key points or the highlights of the subject under study. Still, another research (King, 1990) claimed that there was a significantly positive correlation between cooperative team learning and the learning performance.

In a cooperative team learning environment, there are a number of different roles that students need play. They may include the sharing of the leadership, information receiving and providing, coordinating, conflict handling, etc. Team members with different roles will definitely affect the interactive behavior among themselves and the final outcome of the learning as well. Generally speaking, they are five major categories of interactive behavior (Adams, Carlson, & Hamm, 1990, p.12), including 1) information or idea seeking; 2) information or idea providing; 3) information or idea clarifying or explaining; 4) information or idea inductiveness; and 5) process managing.

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Moreover, as part of the idea generation process, team members may display certain behavior that is related to the process managing (Adams, Carlton, & Hamm, 1990, pp. 13-14). Those processing managing behaviors are: 1) compromising; 2) encouraging; 3) gatekeeping; 4) tension releasing; and 5) sharing of feelings and emotions.

The present research was part of a large research project, which was designed to help students learn math in a collaborative fashion via a Web-based intelligent system in a virtual reality environment called Waltz and then to examine their learning behavior. The purpose of this task was to develop an instrument in order to measure the learning behavior of Taiwan's 8th graders in their learning of the "Pythagorean Theorem." Like this task, the Waltz and an intelligent agent system to learn the concept of "Pythagorean Theorem" were both developed as part of the large on-going research project funded by the National Science Council in Taiwan.

Importance of the Study

In education, it is well known that the most effective learning method is to cultivate students' thinking ability, which is what cooperative or collaborative team learning is all about. In addition to its emphasis on thinking, it also encourages students to learn new materials or skills and to solve problems collectively through interactions. Due to the fact that a lot of junior high school students have math phobia, it was the intent of the study to examine how effective cooperative learning might be able to help overcome or reduce the fear. This was one of the main reasons why this study was designed in the first place. Past studies on collaborative team learning tended to concentrate on the effects of "heterogeneity," such as race, gender, culture, individual ability, etc. among members of a team. Not much attention has been paid to the "homogeneity," which is what the present study was designed to do.

Moreover, studies of cooperative team learning in the past placed heavy emphasis on the comparison of individual learning and group learning in terms of their effectiveness, their motivation, cultivation of self-esteem, etc. Few studies have been conducted to evaluate the group learning process, the interaction among group members, and the group dynamics and their potential impacts. This is especially rare in Taiwan.

Methods

Sampling

The sample used in the project consisted of 134 subjects. They were all eighth graders drawn from two junior high schools in Taiwan. Both schools are located in the central part of the island. One was from an urban area with 65 students and the other from a rural area with 69 students. The sex distribution of the participants was about even in both schools.

Instrument

Since the principal purpose of the present study was to develop a reliable instrument to measure the collaborative team learning behavior of Taiwan's 8th graders in their learning of the "Pythagorean Theorem" in the internet. The scale to be developed and tested was called the internet collaborative learning behavior scale, or ICLBS in short. The scale was initially composed of 44 items. They were compiled after an extensive examination of past studies on the topic and a careful review of a number of related questionnaires. Each item was scored on a seven-point Likert scale with one being the least agreeable and seven being the most agreeable.

Procedure

Experiments were carried out in the computer labs of the two respective junior high schools mentioned above in August 2001. Prior to the experiments, the Waltz system, which was a Web-based intelligent system in a virtual reality environment, was set up in the respective labs. At the outset of each experiment, participants were explained of the nature of the project and were administered a pre-test on materials, that were related to the "Pythagorean Theorem", but had not been taught by their teachers. They were then assigned randomly to small collaborative learning teams with three or four members per team. They were mixed regardless of their ability levels, as judged by their GPAs, gender, computer efficacy, and individual learning style.

At the beginning of each experimental session, members of each collaborative learning team were assigned seats far apart from each other so that no two members would be able to see each other and/or to communicate with each other verbally. Each student was also assigned a computer for his/her sole use. The total duration of the experiment lasted 45 minutes (it should be noted that the students had been classmates for almost two years, thus reducing the need to go through the four group development stages). The first 15 minutes were devoted for the participants to get familiar with the Waltz system and to communicate to each other on any topics they cared to via the internet. In essence, this was the warm-up period for the subjects to get to know the system. The second phase of the experiment was a 30-minute session, which required subjects to learn and solve collaboratively as a team a new algebra problem related to the "Pythagorean Theorem," which was presented in a multimedia form in a virtual reality environment.

At the end of the 30 minutes, they were administered a post-test on the subject again to check how much they had just learned collaboratively as a team. In addition, the 44-item scale was also administered to each of the team members along with some other scales that were not part of the present study. A debriefing was followed immediately thereafter.

Results

Descriptive Statistics

The descriptive statistics for the 44-item internet collaborative learning behavior scale (ICLBS) are presented in Table 1 below.

	Mean	S. D.	Alpha if item Deleted
1.In my team, there existed a positive interdependent relationship (cooperation) among team members during the interactions.	5.52	1.39	0.9016
2. In my team, there existed a negative interdependent relationship (competition) among team members during the interactions*	3.79	1.81	0.9051
3. In my team, there didn't exist any interdependent relationships among team members, resulting in very limited interactions*	4.17	1.74	0.9040
4. In my team, everyone committed oneself to the process of the collaborative team learning	5.04	1.46	0.9034
5. In my team, everyone knew one's own role clearly at any given time	5.06	1.36	0.9020
6. In my team, everyone knew one's responsibility	5.10	1.44	0.9008
7. In my team, everyone did one's duty satisfactorily	5.20	1.42	0.9006
8. In my team, I learned a lot from my teammates that I wouldn't otherwise learn them by myself	4.87	1.57	0.9030
9. In my team, I learned a lot of new knowledge	5.25	1.69	0.9014
10. In my team, I learned a lot of new ways of thinking	5.00	1.72	0.9010
11. In my team, I learned a lot of new study skills	5.12	1.43	0.9001
12. In my team, I learned how to interact actively with others	5.03	1.41	0.8989
13. In my team, I learned how to analyze the problems we faced	5.00	1.72	0.9005
14. In my team, I realized the force of the group synergy	5.06	1.34	0.9000
15. I think the computer contents were very attractive	5.15	1.51	0.9002
16. I think the computer contents were abundant	5.34	1.41	0.9020
17. I think the computer contents were pretty vivid	5.19	1.59	0.9015
18. I was very satisfied with the computerized study environment	5.18	1.34	0.9022
19. The computerized study environment gave me an impulse and made me want to learn more	5.00	1.41	0.9011
20. The computerized study environment actually made me learn more than I had expected to	5.23	1.51	0.9005
21. I think the interactions of our team helped very little on the topics that we were supposed to learn*	3.58	1.70	0.9056
22. I think my teammates rarely challenged each other during the collaborative learning process*	4.16	1.51	0.9034

23. I think most of my teammates lacked any innovative ideas during the collaborative learning process*	3.87	1.55	0.9017
24. I think most of my teammates lacked any active thinking that might help generate new ideas*	4.16	1.52	0.9018
25. I think most of my teammates rarely expressed their opinions during the collaborative learning process*	4.46	1.72	0.9016
26. I think the team interactions in my team were dominated by only a few most of the time	3.98	1.68	0.9018
27. I think my teammates often had no ideas of how to actively participate in the interactions*	3.91	1.66	0.9015
28. I think my teammates often had no ideas of how to analyze the problems we faced*	3.83	1.55	0.9041
29. I think my teammates often had no ideas of what they were doing during the collaborative learning process*	3.83	1.56	0.9052
30. I think my teammates often had no ideas of how to express their opinions during the collaborative learning process*	4.26	1.61	0.9049
31. I think my team did not have any member with a high GPA*	3.63	1.82	0.9054
32. I think my team did not have any member with a high IQ*	3.56	1.69	0.9048
33. In my team, I realized the practical value of team learning	4.80	1.55	0.9012
34. I think collaborative team studying was a good way of learning.	4.97	1.62	0.9009
35. I realized that I needed to improve on my interpersonal skills during the collaborative learning process*	4.68	1.50	0.9017
36. I had no problems expressing my opinions openly in my team.	4.56	1.53	0.9015
37. I had no problems expressing my difficulties openly in my team	4.41	1.61	0.9005
38. I think we all needed to improve our interpersonal skills in my team*	4.44	1.51	0.8999
39. I think my teammates made me realize the importance of appreciating the thoughts and the problems of others more.	4.73	1.46	0.8985
40. I think my teammates made me realize the importance of caring others more.	4.89	1.60	0.8989
41. I think we needed to clarify more of the problems we faced during the collaborative learning process*	4.73	1.54	0.9008
42. I think my teammates lacked a basic trust of each other*	3.95	1.69	0.9008
43. I think my team had a good control of the time during the collaborative learning process.	4.71	1.52	0.8989
44. I think my team processed excellent decision-making abilities	4.78	1.51	0.9004

*denotes reverse coding
Alpha = 0.9038

Table 1 Descriptive Statistics and Reliability Analysis

Reliability Analysis

Cronbach alpha correlation coefficients were computed for each of the 44-item scale. Table 1 above presents the results of the reliability analysis as well as the means and the standard deviations. As can be seen, the Cronbach alpha coefficients were 0.9038 for the total scale and at least 0.8985 to as high as 0.9052 for the individual items. The results indicated that the 44-item internet collaborative learning behavior scale (ICLBS) and the individual item had high internal consistency. As such, all 44 items were retained for further analyses.

Factor Analysis

Once the internal consistency analysis was completed, a factor analysis was carried out. A principal component analysis of the 44-item was conducted using Oblimin with Kaiser Normalization procedure of the Statistical Package for the Social Sciences. The procedure extracted 11 factors with eigenvalues greater than 1.0. The largest of the 11 factors accounted for 22.06% of the pre-rotation variance whereas the smallest factor accounted for 2.36% of the variance, for a total variance of 70.03%.

Using Gorsuch's (1983) recommendation of considering both the Kaiser-Guttman criterion (Kaiser, 1970) of retaining factors with eigenvalues greater than 1.0, it seemed that the 11-factor model was inappropriate since three of the 11 factors only accounted for between 2% and 3% each. It was decided to

Variables	Computer-Usage	Role behavior	Openness	Passiveness	Incapacity
V1		-.641			
V2					
V3					
V4		.718			
V5		.776			
V6		.832			
V7		.826			
V8		.707			
V9			.720		
V10			.745		
V11			.689		
V12			.611		
V13			.589		
V14			.544		
V15	.691				
V16	.667				
V17	.715				
V18	.721				
V19	.731				
V20	.740				
V21				.476	
V22				.692	
V23				.757	
V24				.669	
V25				.542	
V26					.565
V27					.680
V28					.796
V29					.787
V30					.647
V31					.580
V32					.568
V33					
V34	.518				
V35					
V36			.587		
V37			.643		
V38			.553		
V39			.693		
V40	.549		.634		
V41			.523		
V42					.553
V43			.691		
V44			.580		
Total variance explained	22.06%	11.78%	6.65%	5.65%	4.38%

Table 2: Rotated Component Matrix

review the 11-factor model further using the scree test as suggested by Cattell (1966). A quick visual check of the scree plot revealed two break points in the plotted line of eigenvalues after 5 factors, which accounted accumulatively for 50.53%, and 7 factors, accounted collectively for 58.27%.
The rotated component matrix was utilized for the interpretation of the final factors to be extracted. Since the sample size was 134, an item in order to be retained had to have a component coefficient of 0.50 or greater to be statistically significant, according to Hair, Andersen, Tatham, and Black (1998, p.112). Another word, items with component coefficients of less than 0.50 should be deleted from the instrument. The results of the rotated component matrix tended to indicate that the five-factor model was more appropriate than the seven-factor model. Table 2 shows the results of the factor analysis with the five-factor model.

Discussion and Summary

The results showed in Table 2 above indicated that the scale was basically a five-factor model. Those five factors were respectively named computer usage, role behavior, openness, passiveness, and incapacity..

Computer Usage Factor

The inclusion of the computer usage factor with seven items in the five-factor model, is understandable. This is because computers are rapidly becoming part of the educational process from K to G12 in Taiwan. A major difference between collaborative learning with and without computers is that end users have technological tools that can allow for dynamic exploration via time, space, and ideas in an interactive method.

The successful use of computers means involving both teachers and students in the learning process in a completely different way. Web-based collaborative team learning can help sharpen students' ability to think critically and to develop independent judgments. It is also intended to teach cooperative social skills, individual accountability and group information processing within a group environment.

With the advancement of complicated computer software nowadays, it is no wonder that the Web can be and has been employed easily to collaborate learning on how to undertake a task or project so long as it also offers abundantly attractive multimedia contents. The emergence of this factor certainly attests to that.

"When the excitement of discovery is assisted by peers and the imaginative spirit of inquiry, learning is at its best (Hamm & Adams, 1992, p.87)." It is not surprising to note that "the computer is a natural learning vehicle for cooperative group work (Mandell & Mandell, 1989)."

Role Behavior Factor

As any group behavior researchers can readily attest that there are a variety of roles that team members need to play. They may include, but are not limited to, sharing of the leadership, information receiving and providing, coordinating, conflict handling, etc. What role one member may play within a group depends, to a large extent, on one's perceived concept of identify. The importance of the role of identity was not recognized until the social identity theory was introduced (Tajfel and Turner,1979) . In essence, there are four properties of identity, including identity as rational, situational, interactive, and affective (Hertz-Lazarowitz & Miller, 1992, p.204). The identification of the second factor, role behavior factor, which contained six items, certainly verifies the point.

Openness Factor

How successful a team functions depends, to a large extent, on how open the team and its members are. This is because openness has a lot to do with imagination, artistically sensitiveness, and intellectualism. It also encourages and opens up new ways of communication, stimulates more creativity and innovations within a group. This is not to mention that openness may also help build up the cohesiveness in a group, which is the degree to which group members are attracted to each other and are more likely to be motivated to stay in the group so that they get a stronger feeling of "I belong." Needless to say, there is a potentially positive correlation between the group cohesiveness and the group productivity.

The 13 items that were identified as part of this factor included such items as "expressing my opinion openly (v.36)," "expressing my difficulties openly (v.37)," "made me realize the importance of appreciating the

thoughts and the problems of others more (v.39)." This is perhaps why the "force of the group synergy (v.14)" was also recognized here as well.

Most of the 13 items are essential to the building of "trust," which is a crucial issue and perhaps the most difficult one to deal with when it comes to the effectiveness of a group or an organization (Gammetta, 1988; Lewis & Weigert, 1985; Mayer, Davis &Schoorman, 1995). Numerous research (Chidambaram, 1996; Deutch, 1958; Handy, 1995; Leidner & Jarvenpaa, 1995; Meyerson, Weick & Kramer, 1996) has uncovered this. It is not surprising to hear that "Although trust usually is thought of in the context of a long-term relationship, when people join teams for a short period of time, building and maintaining trust is more difficult and, therefore, more important (Durate and Snyder,1999, (p.83)."

Passiveness Factor

It is not surprising to see that "passiveness" showed up in the factor analysis as one of the key factors, which covered 5 items. This may be attributed to two reasons. First, collaborative team learning is a very new way of learning in Taiwan's culture. There has been a tendency to over-emphasize the individual accomplishment at the expense of the group learning. As a result, students often find themselves in a state of competing each other than in a state of working together cooperatively. Second, whenever students are assigned a group project, they are always given the opportunity to form their own teams. As such, groups are often composed of close friends, who are often time socialized together outside the classroom as well. In groups like those, projects are often time carried out not by the entire team, but by a so-called the "core group.". In other words, "free rider" is a common problem. The emergence of the "passiveness" factor is therefore understandable and not surprising.

Incapacity Factor

This factor had eight items and is a very interesting one. It is interesting because it showed all the negative aspects of the teamwork. The indifference of its members might be attributed to a fact that most, if not all, of its members were followers waiting for someone to stand up to take the leadership role. Yet, no one did emerge as either the team leader or the opinion leader because of low IQ (v. 32) and/or low GPA (v. 31). As a result, every one seemed to have lost in the collaborative team learning process. This was why the group as a whole did not know how to participate (v. 27), how to analyze (v. 28), what to do (v. 29), and how to express their opinions (v. 30). Basically, the whole learning process was a terrible mess for the group. This situation is not unusual for a self-directed or self-managing team, which is common with today's virtual teams. Therefore, it is crucial to have a balanced team with members equipped with different background, experiences and functions.

Conclusion

The present study showed that it is possible to construct a questionnaire in order to assess the interactive learning behavior of 8th grade students in a collaborative team learning environment relying on multimedia and virtual reality technologies. The level of homogeneity of the scale as assessed by Cronbach's alpha (0.9038) was very high. The final form of the scale was composed of five factors with 39 items in total. While this is true, two things need be emphasized here nonetheless. First, the findings of the study are only preliminary and should be treated as such. Second, since the subjects of the study were 8th grade students in Taiwan, the conclusion should not be generalized and the scale may not be applicable universally.

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Acknowledgements

This research was supported by a grant from the National Science Council of the Republic of China in Taiwan to the first author. The data presented, the statements made, and the views expressed are solely the responsibility of the author.

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